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PENSOFT

A herpetological survey of Edith L. Moore Nature Sanctuary

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Abstract

Urban herpetology deals with the interaction of amphibians and reptiles with each other and their environment in an urban setting. As such, well-preserved natural areas within urban environments can be important tools for conservation. Edith L. Moore Nature Sanctuary is an 18-acre wooded sanctuary located west of downtown Houston, Texas and is the headquarters to Houston Audubon Society. This study compared iNaturalist data with results from visual encounter surveys and aquatic funnel traps. Results from these two sources showed 24 species belonging to 12 families and 17 genera of herpetofauna inhabit the property. However, several species common in surrounding areas were absent. Combination of data from community science and traditional survey methods allowed us to better highlight herpetofauna present in the park besides also identifying species that may be of management concern for Edith L. Moore.

Keywords
Community science, iNaturalist, urban herpetology

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Introduction

Increasing pressure from human disturbance and expansion is threatening global wildlife populations (Butchart et al. 2010; Hamer and McDonnel 2010). According to Pimm et al. (2014), the rate of extinction for wildlife around the world is 1,000 times higher than the rate of extinction without human disturbance. Human disturbance includes increased human expansion, consumption of natural resources, and urbanization, the expansion of urban areas into previously rural areas (Pimm et al. 2014; Veach et al. 2017). As anthropogenic activities continue to affect global wildlife populations, urbanization remains one of the fastest growing issues for biodiversity and wildlife conservation. (Veach et al. 2017; United Nations 2014).

Urbanization is a global phenomenon. The world's population is growing rapidly and by 2050, 66% of the world's population will be residing in urban areas (United Nations 2014). As we expand into these areas, near permanent changes occur in the natural ecosystem (Guneralp and Seto 2013). Habitat fragmentation and alteration, introduction of invasive species, and pollution of various types (noise, artificial light, sewage etc.) all have negative effects on native fauna (Cureton II et al. 2014; Hunt et al. 2013; Riley et al. 2005; Rebele 1994; Ciach and Fröhlich 2017). The evidence clearly shows that urbanization has extreme consequences on native species.

Community science involves collaboration between researchers and the greater community in the research

process. Community members who participate in community science are often involved in data collection or analysis (Silvertown 2009; Dickinson et al. 2010; Kullenburg and Kasperowski 2016). Although a relatively new tool for research, it has grown considerably in recent years and has been highly effective in ecology-based research (Dickinson et al. 2010; Nature Editorial 2015). In particular, ecological surveys of urban areas can benefit from crowdsourcing observation data (Cooper et al. 2007). Community science has the benefit of scale, the ability to engage local communities in conservation, and allows projects that normally would be impossible to be completed otherwise (Cooper et al. 2007). Community science is often accomplished through websites, mobile apps and software that allows citizens to contribute to a dataset.

Herpetofauna (reptiles and amphibians) are especially at risk. Globally, 41% of amphibians and 19% of reptiles are threatened with extinction (IUCN 2017; Bohm et al. 2013). Urbanization has shown to have direct effects on herpetofauna populations, with urban areas displaying lower herpetofaunal biodiversity and richness (Rubbo and Kiesecker 2005; Hamer and McDonnell 2010). As urbanization increases, herpetofaunal communities continue to be at risk of extinction. For this reason, it is paramount to study herpetofauna conservation as it relates to urban areas (Fitzgerald et al. 2018).

Urban herpetology deals with the interaction of amphibians, reptiles and humans with each other and their environment in urban settings (Mitchell et al. 2008). Miller (2006) urges that increased interaction with biodiversity results in a greater appreciation for wildlife and conservation efforts. Placing education in the context of natural protected areas may have dramatic effects on future conservation efforts (Jiminez et al. 2015). Sousa et al. (2016) found that teenage students who had contact with ponds as part of their education had an improved attitude and knowledge toward biodiversity and its related functions. Laladhas et al. (2013) finds that students who are involved with their local biodiversity, show increased respect and a greater understanding of nature at large. It is for these reasons that maintaining proper biodiversity in local regions can have dramatic effects on future actions as they relate to conservation.

Study Area

Houston, Texas is the fourth largest city in America and has undergone a rapid expansion (US Census Bureau 2020). Compared to a national growth rate of 24%, Houston underwent 50% population growth over the same 20-year period (US Census Bureau 2020). However, this rapid growth was not without negative effects. Increased flooding events, extreme heat events, and runoff into watersheds have all been recorded in Houston in response to its growth rate (Munoz et al. 2017; conlon et al. 2016). Although Houston maintains 370 developed parks and 200 greenways throughout its city (Houston Parks), the effects of urbanization directly affect Houston's flora and fauna. Due to its rapid growth, affinity for green spaces and urban parks, and its spot as one of America's major urban areas, Houston serves as an ideal location to study urban effects on wildlife.

The Edith L. Moore Nature Sanctuary is a 7.3 ha (18 acre) wooded nature preserve located near the intersection of Beltway 8 and US Interstate Highway I-10 (Fig. 1; centered at 29.7713°N, 095.5695°W). The sanctuary was established as a protected ranchland in 1931, maintained by the late Edith L. Moore and her husband. In 1976, the reserve was willed to Houston Audubon under the condition that it be maintained as a nature preserve. Today, it serves as the headquarters for Houston Audubon and has been kept according to Ms. Moore's wishes.

The habitat is a mix of pine and hardwood forest located within the Gulf and Prairie Marsh ecoregion (TPWD 2018). The park borders a portion of Rummel Creek, a watershed of Buffalo Bayou, and exhibits periodic flooding and erosion events along its banks (HCFCD Buffalo Bayou 2018). Surrounding the sanctuary is the Nottingham subdivision. The park is maintained by Houston Audubon staff and volunteers. Although heavily active in community conservation efforts, to date a traditional survey of herpetofauna had never been carried out on the property.

Non-native herpetofauna species such as *Hemidactylus turcicus* (Linnaeus, 1758), *Euluetherodactylus cystignathoides* (Cope ,1878), and *Anolis sagrei* (Duméril & Bibron, 1837) have naturalized in the surrounding area, but consequences of their introduction are hard to determine and study. It is expected that other species like the *Osteopilus septentrionalis* (Duméril & Bibron, 1841) are likely to naturalize too. How these affect native species' abundance and their ecological roles can be determined with documentation of their expanding ranges.

In August of 2017 (immediately prior to the survey date), Edith L. Moore was heavily flooded by Hurricane Harvey, with some areas flooded with over 15 feet of water. Although we began this study shortly after Harvey, without a baseline data of species presence, it is impossible to know exactly what existed prior to this natural disaster. Although Hurricanes have been shown to have negative effects on herpetofauna communities (Schriever et al. 2006), it was not possible to study the effects of the hurricane on Edith L. Moore Sanctuary.

Methods

This study has used a community science software, iNaturalist, and traditional survey techniques for herpetofauna. By using this multifaceted approach, we hoped to gain a better understanding of herpetofauna present at Edith L. Moore Sanctuary.

Data from iNaturalist were pulled from between February 11, 2015 (earliest available information) and May 12, 2018 (the last date of the surveys). The location pulled was labeled as the "Edith L. Moore Nature Sanctuary –

Figure 1. Satellite image of Edith L. Moore in relation to the southern North America. Park boundaries are outlined in pink.

Local Administrative Area" within the iNaturalist system. All data downloaded contained date, time, GPS coordinates, taxonomy, pictures and any notes filled out by the submitter. Only "Research Grade" records were used, and all records were re-checked for correct identification. Records that could not be identified to family level were not considered. Individuals caught via traditional survey techniques were also uploaded to iNaturalist but were not included in the iNaturalist dataset used to complement our survey data (to avoid duplication of data).

Visual Encounter Surveys (VES) are a standard method used in herpetological surveying (Fitzgerald 2012). VES is an opportunistic search for target species along specified routes and transects (Dodd 2016). VES is relatively simple and inexpensive to run and has proven to be effective at estimating presence of a variety of faunal groups (Flint and Harris 2005; Rodrigues et al. 2015; Donnelly et al. 2005).

The VES were designed to search the entire 7.3 ha property and were conducted both along existing trails and through set transects. Surveys were conducted twice for each survey day once 3 hours before sunset and again 1 hour after sunset, with 1 surveyor per survey. Surveys ended when the entire transect was traversed. Refugia including logs, rocks, or other debris, was flipped within 5 m of the transect. Transects were performed in two parts of the park that had little or no direct trail access. Transects were walked in straight lines as terrain and foliage allowed and started from the same spot on each trail. The transect path was determined in a way that would allow covering areas typically not accessed from the main trails. The path taken is shown in Figure 2.

Any individuals collected were either measured at the collection site or stored in plastic containers or cloth bags to be measured after completion of the survey. Individuals were not marked. Individuals kept until the end of the survey were released at the same location they were found after taking measurements. Measurements taken are explained in further detail in "Data Collection". Transects were designed such that repeated captures of individuals during the same survey event would be rare (i.e., transects did not search the same area twice during the same survey period). Further, individuals found during pre-sunset surveys were released during the subsequent post-sunset transect to avoid recounting the same individual during the same day. Captured post-sunset individuals were released that same night after taking measurements.

Aquatic funnel traps were placed in a permanent pond on the property (Fig. 2), 10 traps were placed in the pond at the same location each survey day. Traps were placed 30 minutes before sunset and checked the following morning before being removed. Although traps can be left out for longer periods of time, heavy foot traffic around the primary trapping site by the public could lead to potentially unsafe conditions for both the public

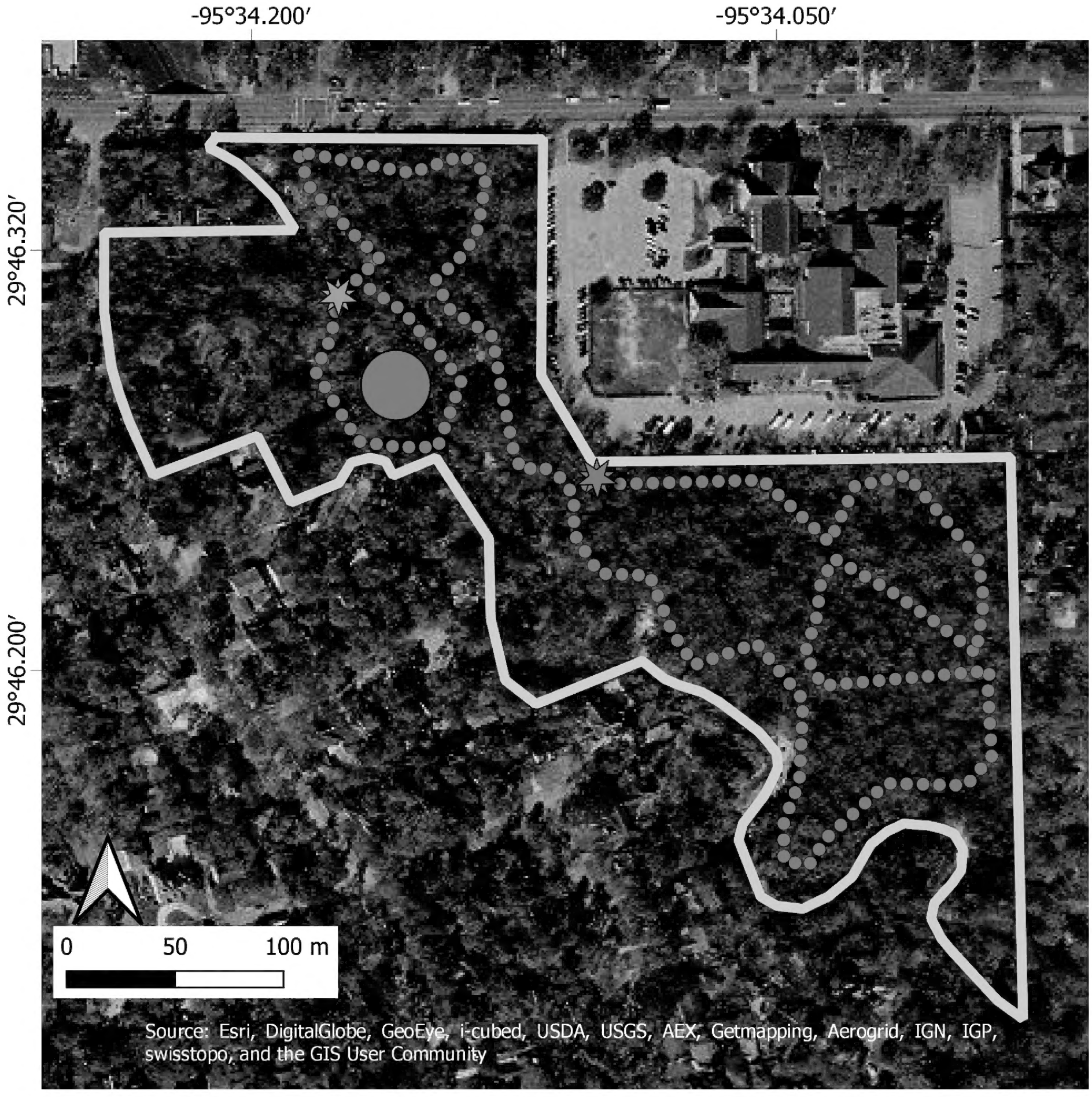

Figure 2. Surveying methodology. Transect surveys are marked by red dots. The start of the transect is noted by the gold star, with the end of the survey marked by the green star. Aquatic funnel traps were placed within the area noted by the blue ellipse.

or any caught animal. Traps were partially submerged in water such that caught animals retained the ability to breathe. Funnel traps were originally baited with dry dog food. However, manipulation by racoons, *Procyon lotor* (Linnaeus, 1758), ultimately required traps to stop being baited. Manipulation in this case was defined as traps being placed on their side, dragged onto land, or having holes ripped through the mesh. Although Rummel Creek, a perennial stream, runs through the park, traps were not placed in it. Rummel Creek is a flood path for Buffalo Bayou and during rain events the water level may rapidly rise more than 3 meters without prior warning.

Any individual sighted or captured was logged using the ODK Collect mobile app utilizing an .XLS survey. The .XLS survey includes fields for date, time, GPS coordinates, species, morphometric measurements, pictures of the individual, and any notes. GPS coordinates were taken using native phone GPS capability. Although accuracy was a concern, in an urban area we were able to get an accurate reading with 10 m resolution. This also allowed for good comparison to iNaturalist data that also uses native cellphone GPS. Weights were collected in grams using a digital scale. Length measurements included snout vent length and tail length for snakes, lizards, and amphibians or plastron and carapace length for testudines. These measurements were taken with digital calipers or measuring tape. Pictures were taken either with a phone or with a zoom lens (Canon lens EF 75-300) on a DSLR camera (Canon Rebel T5) to be able to identify the species later. Surveys were uploaded once the phone was in range of wi-fi and all records uploaded were checked for validity. In conjunction with this .XLS

survey, a field notebook was kept with basic information about each specimen collected (time, date, species, count) in the event of app failure.

Results

Data from iNaturalist revealed 126 individual sightings of 21 species of amphibians and reptiles (15 genera, 10 families) had been uploaded by citizen scientists at Edith L. Moore Sanctuary. These records included 5 amphibian species from 4 families and 3 genera, and 16 reptile species (3 turtle, 8 snake, and 5 lizard) from 6 families and 12 genera (Fig. 3)

A total of 16 VES were carried out on 8 days between January 20, 2018 and May 1, 2018. The VES varied from 70 to 130 minutes. In total 102 individuals were observed during these surveys (Table 1). We recorded 6 amphibian species from 4 families and 4 genera, (Fig. 4) and 9 reptile species (3 turtle, 2 snake, and 4 lizard) from 6 families and 8 genera (Fig. 5). In total 15 species from 10 families and 12 genera were found during survey events (Fig. 3).

Class Amphibia
Family Bufonidae

Incilius (= *Bufo*) *nebulifer* (Girard, 1854)

Examined material. UNITED STATES • 6 via survey, 9 via iNaturalist; Texas, Harris County, Houston; 29.7714°N, 095.5697°W; first encounter on 17 Feb. 2018; capture via transect survey.

Identification. This species is marked by triangular parotoids, and a deep valley between prominently developed cranial crests. A light mid-dorsal stripe is typically present with prominent dark lateral stripes helping to further identify this species from the *Anaxyrus* genus. Other species of *Incilius* are not known to occur in Texas (Powell et al. 2016). A number of authors retain the genus *Bufo* for this species (Pauly et al. 2009).

Family Eleutherodactylidae

Eleutherodactylus cystignathoides (Cope, 1878)

Examined material. UNITED STATES • 5 via survey, 3 via iNaturalist; Texas, Harris County, Houston; 29.7700°N, 095.5666°W; first encounter on 20 Jan. 2018; capture via transect survey.

Identification. Nonnative species. This small frog is marked by dark lines starting from the nostrils and continuing through the eyes. Although hard to distinguish from *Eleutherodactylus marnockii* (Cope, 1878), their range does not overlap at this study site and *E. cystignathoides* is typically darker with a more distinct pattern (Powell et al. 2016).

Table 1. List of herpetofauna species encountered at Edith L. Moore Sanctuary, Houston, Texas, USA. The number of individuals is listed as reported in iNaturalist and from surveys conducted during this study.

Taxon	iNaturalist	Survey	Total
Amphibia	19	36	55
Bufonidae	5	6	11
Incilius nebulifer	5	6	11
Eleutherodactylidae		5	5
Eleutherodactylus cystignathoides		5	5
Hylidae	1		1
Hyla cinerea	1		1
Microhylidae	1	2	3
Gastrophryne carolinensis	1	2	3
Ranidae	14	23	37
Rana catesbeiana	12	14	19
Rana clamitans	2	5	7
Rana sphenocephalus		2	2
Not identified at species level		2	2
Reptilia	109	122	185
Chelydridae	5	2	4
Chelydra serpentina	5	2	4
Colubridae	64	5	69
Haldea striatula	4	3	7
Heterodon platirhinos	10		10
Nerodia erythrogaster	16		16
Nerodia fasciata	17	2	19
Nerodia rhombifer	9		9
Storeria dekayi	1		1
Thamnophis proximus	7		7
Dactyloidae	15	10	25
Anolis carolinensis	6	2	8
Anolis sagrei	9	8	17
Elapidae	1		1
Micrurus tener	1		1
Emydidae	27	55	82
Not identified at species level		12	12
Pseudemys concinna	1	2	3
Trachemys scripta	26	41	67
Scincidae	9	49	58
Plestiodon fasciatus	7	37	44
Plestiodon laticeps	1		1
Plestiodon sp.		1	1
Scincella lateralis	1	11	13
Testudinidae		1	1
Terrapene carolina		1	1
Totals	**142**	**158**	**300**

Family Microhylidae

Gastrophryne carolinensis (Holbrook, 1836)

Examined material. UNITED STATES • 2 via survey, 2 via iNaturalist; Texas, Harris County, Houston; 29.7715°N, 095.5699°W; first encounter on 24 Feb. 2018; capture via transect survey.

Identification. This species exhibits a pointed head and a skinfold across the back of the head. They can range from a gray or silvery to brown or reddish with various intensities of dark and light. This species can be distinguished from *Gastrophryne olivacea* (Hallowell, 1857) by its strongly pigmented and mottled belly and from

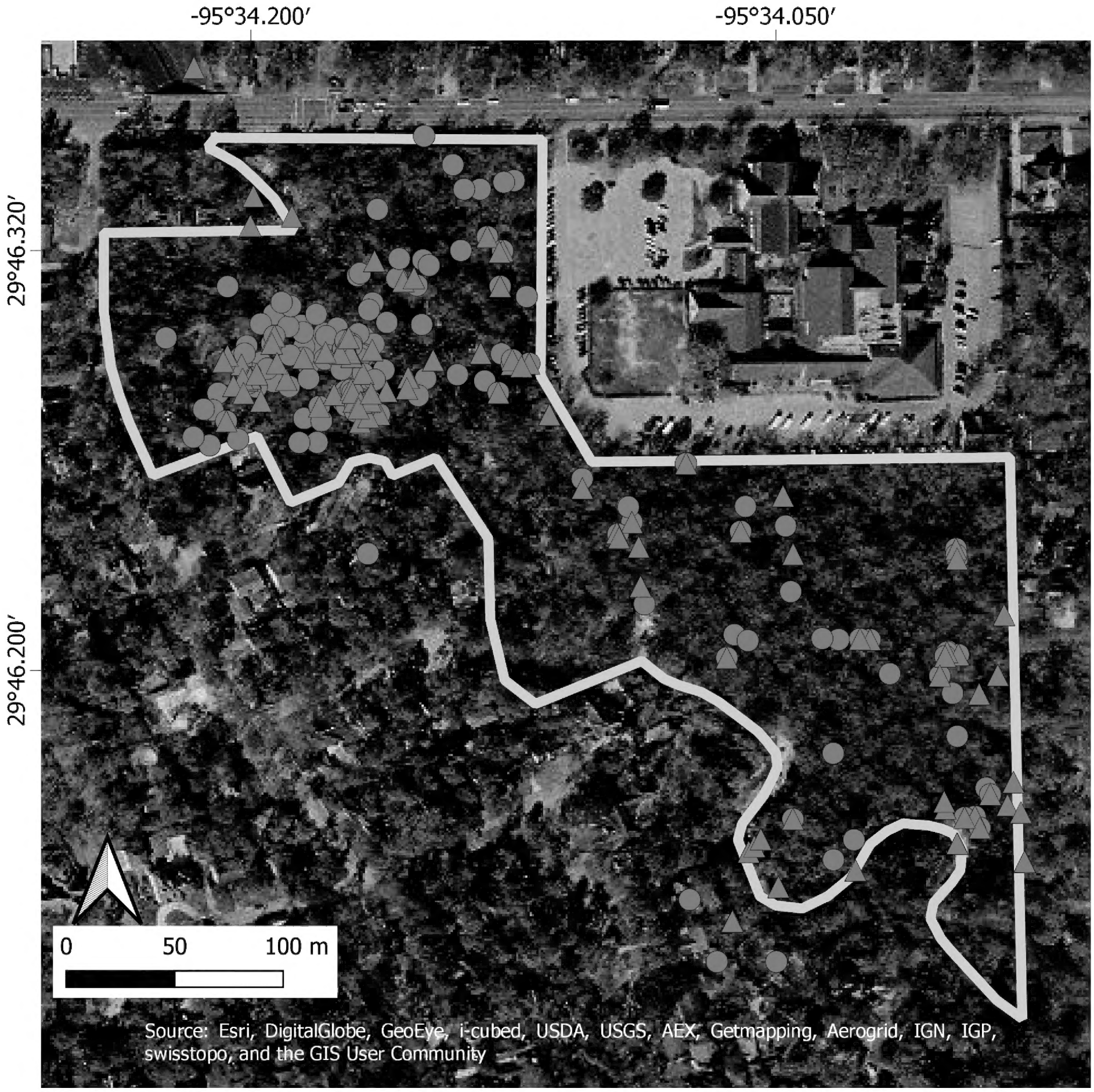

Figure 3. Results from surveys and iNaturalist data. Green ellipses mark iNaturalist data. Red triangles mark survey data. Points found outside the park boundary are likely due to GPS accuracy issues.

Hypopachus variolosus (Cope, 1866) by the absence of 2 spades on each hindfoot. (Powell et al. 2016)

Family Ranidae

Rana catesbeiana (Shaw 1802)

Examined material. UNITED STATES • 14 via survey, 17 via iNaturalist; Texas, Harris County, Houston; 29.7713°N, 095.5695°W; first encounter on 21 Jan. 2018; capture via transect survey.

Identification. This species is characterized by generally large size and an olive, green or brown body color often fading to green on the head. Additionally, the eardrum is rather conspicuous and is larger than the eye in males. This species can be identified from *Rana clamitans* (Latreille, 1801) by the absence of dorsolateral folds (Powell et al. 2016). A number of authors use *Lithobates* as the genus name for this species. We use *Rana*, following Yuan et al. (2016).

***Rana clamitans* (Latreille, 1801)**

Examined material. UNITED STATES • 5 via survey, 6 via iNaturalist; Texas, Harris County, Houston; 29.7713°N, 095.5700°W; first encounter on 17 Feb. 2018; capture via transect survey.

Identification. This species is characterized by a green, brown or bronze color. The eardrum is rather conspicuous and twice the size of the eye in Males. This species can be identified from *Rana catesbeiana* and *Rana sphenocephala* (Cope, 1868) due to its prominent dorsolateral folds that extend approximately two-thirds the length of the body but do not reach the groin (Powell et al. 2016). A number of authors use *Lithobates* as the genus name for this species. We use *Rana*, following Yuan et al. (2016).

***Rana sphenocephala* (Cope, 1886)**

Examined material. UNITED STATES • 2 via survey, 2 via iNaturalist; Texas, Harris County, Houston; 29.7712°N, 095.5694°W; first encounter on 4 Feb. 2018; capture via transect survey.

Identification. This species exhibits an elongated head with a pointed snout. Typically exhibiting a brownish color with light lines on the upper lip and distinct light spots on the eardrum. This species can be identified from *Rana catesbeiana* and *Rana clamitans* due to its prominent dorsolateral folds that extend down the length of the body reaching the groin (Powell et al. 2016). A number of authors use *Lithobates* as the genus name for this species. We use *Rana*, following Yuan et al. (2016).

Reptilia
Family Chelydridae

***Chelydra serpentina* (Linnaeus, 1758)**

Examined material. UNITED STATES • 2 via survey, 4 via iNaturalist; Texas, Harris County, Houston; 29.7711°N, 095.5701°W; first encounter on 17 Feb. 2018; capture via transect survey.

Identification. This species possesses a large head and a rough carapace with 3 well-defined longitudinal keels. The tail is as long as the carapace or longer with a saw-toothed appearance. This species can be distinguished from *Macrochelys temminckii* (Troost, 1835) by the absence of extra scute rows between the marginals and pleurals. Additionally, this species differs from mud and musk turtles (Kinosternidae) by the rougher carapace and a its cross shaped plastron (Powell et al. 2016).

Family Colubridae

***Haldea striatula* (Linnaeus, 1766)**

Examined material. UNITED STATES • 3 via survey, 8 via iNaturalist; Texas, Harris County, Houston; 29.7714°N, 095.5687°W; first encounter on 17 Feb. 2018; capture via transect survey.

Identification. This species exhibits keeled scales atop a light gray or brown color. This species can be distinguished from other species of snake by its five upper labials, fused internasals and keeled scales (Powell et al. 2016).

***Nerodia fasciata* (Linnaeus 1766)**

Examined material. UNITED STATES • 2 via survey, 17 via iNaturalist; Texas, Harris County, Houston; 29.7713°N, 095.5700°W; first encounter on 24 Feb. 2018; capture via transect survey.

Identification. This species possesses red, brown or black crossbands and dark stripes from the eye to the angle of the jaw. This species can be identified from *Nerodia rhombifer* (Hallowell, 1852) by the absence of a chain like pattern, and from *Nerodia erythrogaster* (Forster, 1771) by the presence of squarish spots along sides of the belly (Powell et al. 2016).

Family Dactyloidae

***Anolis carolinensis* (Voigt, 1832)**

Examined material. UNITED STATES • 2 via survey, 8 via iNaturalist; Texas, Harris County, Houston; 29.7714°N, 095.5700°W; first encounter on 17 Feb. 2018; capture via transect survey.

Identification. This species has an elongated hear, keeled ventral scales, and can either be green or brown. Lips and belly are white in corloration with dewlap usually being pink. This species can be identified from *Anolis sagrei* (Duméril & Bibron, 1837) by a round tail in cross section and by the dewlap (Powell et al. 2016).

***Anolis sagrei* (Duméril & Bibron, 1837)**

Examined material. UNITED STATES • 8 via survey, 13 via iNaturalist; Texas, Harris County, Houston; 29.7713°N, 095.5692°W; first encounter on 3 Feb. 2018; capture via transect survey.

Identification. Nonnative species. Stocky with brown or gray keeled ventral scales. Their tale is laterally compressed with mails sometimes possessing a tail crest. Dewlap usually orange red with light borders. This species can be distinguished from *Anolis carolinensis* (Voight, 1832) by its dewlap and laterally compressed tail (Powell et al. 2016).

Family Scincidae

***Plestiodon fasciatus* (Linnaeus, 1758)**

Examined material. UNITED STATES • 31 via survey, 15 via iNaturalist; Texas, Harris County, Houston; 29.7714°N, 095.5697°W; first encounter on 15 Dec. 2017; capture via transect survey.

Identification. This species is black with 5 white or yellow longitudinal stripes and a blue tail when young. With age, this pattern and color darkens and fades with males often, but not always, becoming nearly entirely brown. During the breeding season (spring) adult males exhibit orange-red coloring on the jaws. This species can be distinguished from *Plestiodon laticeps* (Schneider, 1801) by the presence of 4 labial scales as opposed to 5 and 26–30 longitudinal rows of scales around the midbody (Powell et al. 2016). On one occasion we discovered an individual with 4 labials on one side of the jaw and 5 on the other, with 30 longitudinal rows of scales. Although *Plestiodon laticeps* was never discovered on surveys and only once on an iNaturalist report, we opted to only identify this individual down to genus and cannot confirm the presence of *P. laticeps* on the property during our study.

***Scincella lateralis* (Say, 1822)**

Examined material. UNITED STATES • 11 via survey, 9 via iNaturalist; Texas, Harris County, Houston;

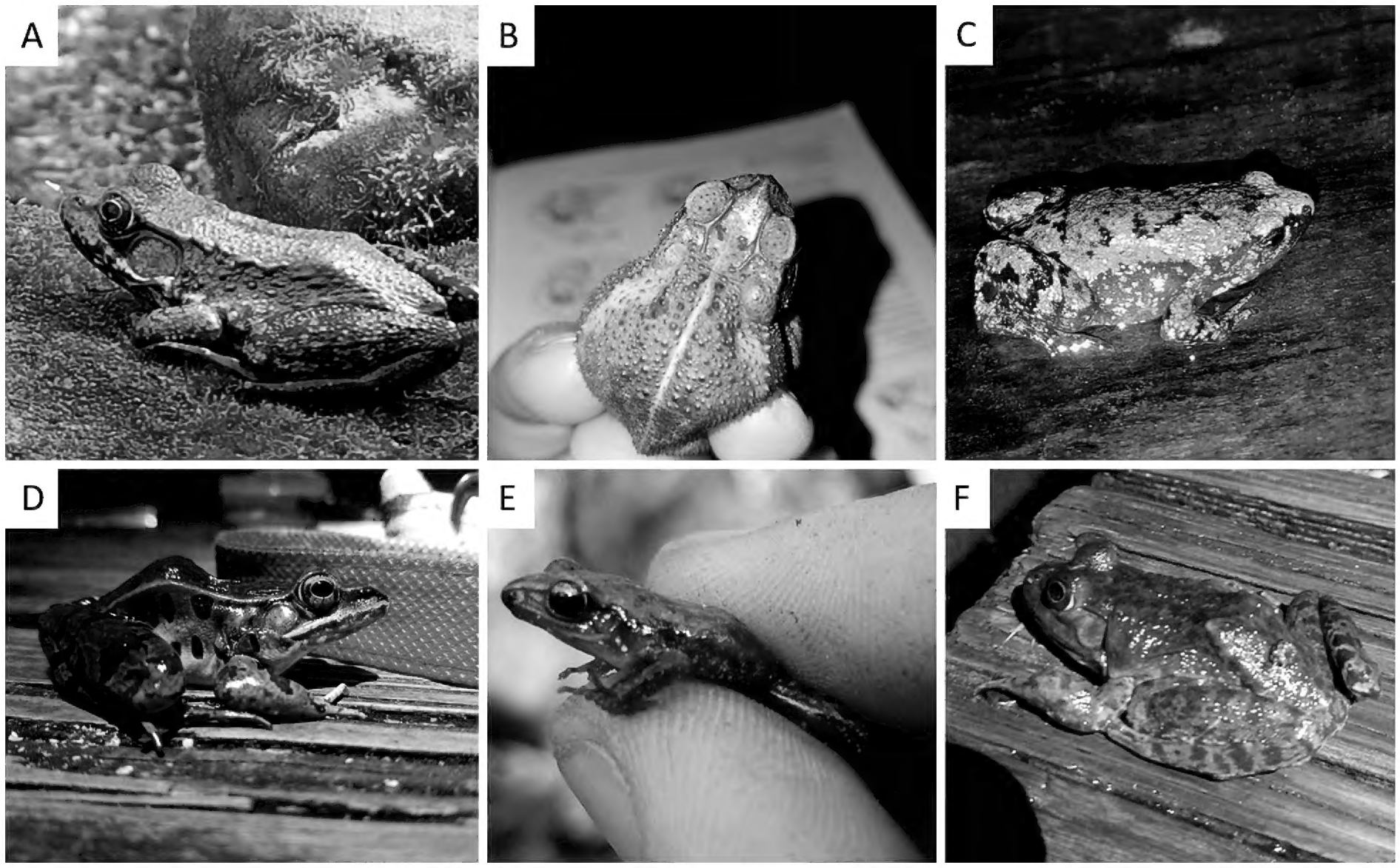

Figure 4. Amphibians found during transect surveys. **A.** *Rana clamitans*. **B.** *Incilius nebulifer*. **C.** *Gastrophryne carolinensis*. **D.** *Rana sphenocephalus*. **E.** *Eleutherodactylus cystignathoides*. **F.** *Rana catesbeiana*.

29.7709°N, 095.5679°W; first encounter on 20 Jan. 2018; capture via transect survey.

Identification. Golden to blackish brown with dark dorsolateral stipes. Reaches a max size of 14.6 cm head to tail (5.7cm SVL). *S. lateralis* can be distinguished from sympatric species by its coloration, dorsolateral stripes, and the presence of a "window" on the lower eyelids (Powell et al. 2016).

Family Emydidae

***Pseudemys concinna* (Le Conte, 1830)**

Examined material. UNITED STATES • 2 via survey, 1 via iNaturalist; Texas, Harris County, Houston; 29.7691°N, 095.5676°W; first encounter on 13 Apr. 2018; capture via transect survey.

Identification. This species is largely aquatic and exhibits five light striped between eyes. This species was distinguished from *Trachemys scripta* (Thunberg, 1792) by the absence of broad yellow or red stripes or patches behind the eyes (Powell et al. 2016). Aquatic turtles were often encountered during surveys and typically identified using either binoculars (Bushnell 7×35 Sportview) or through a telephoto camera lens (Canon lens EF 75-300). In the event a proper ID could not be ascertained the individual was only identified down to family (Emydidae).

***Trachemys scripta* (Thunberg 1792)**

Examined material. UNITED STATES • 42 via survey, 24 via iNaturalist; Texas, Harris County, Houston; 30.6221°N, 096.3517°W; first encounter on 15 Dec. 2017; capture via transect survey.

Identification. This species is largely aquatic and abundant in the region. It can be distringuished from *P. concinna* by the presence of broad yellow or red stripes/patches behind the eyes (Powell et al. 2016). Aquatic turtles were often encountered during surveys and typically identified using either binoculars (Bushnell 7×35 Sportview) or through a telephoto camera lens (Canon lens EF 75-300). In the event a proper ID could not be ascertained the individual was only identified to family (Emydidae).

Family Testudinidae

***Terrapene carolina* (Linnaeus, 1758)**

Examined material. UNITED STATES • 1 via survey; Texas, Harris County, Houston; 29.7714°N, 095.5701°W; first encounter on 1 Apr. 2018; capture via transect survey.

Identification. A primarily terrestrial species with a high domelike shell. A middorsal keel can be seen that may have faded in adults. This species can be identified from aquatic species of turtle by its unwebbed toes and a hinged, movable plastron (Powell et al. 2016).

Discussion

The results of our survey show that Edith L. Moore Nature Sanctuary contains a wide range of herpetofauna considering its urban location and relatively small area (7.3 ha). Combined survey and iNaturalist data showed a total of 24 species (7 amphibian species, from

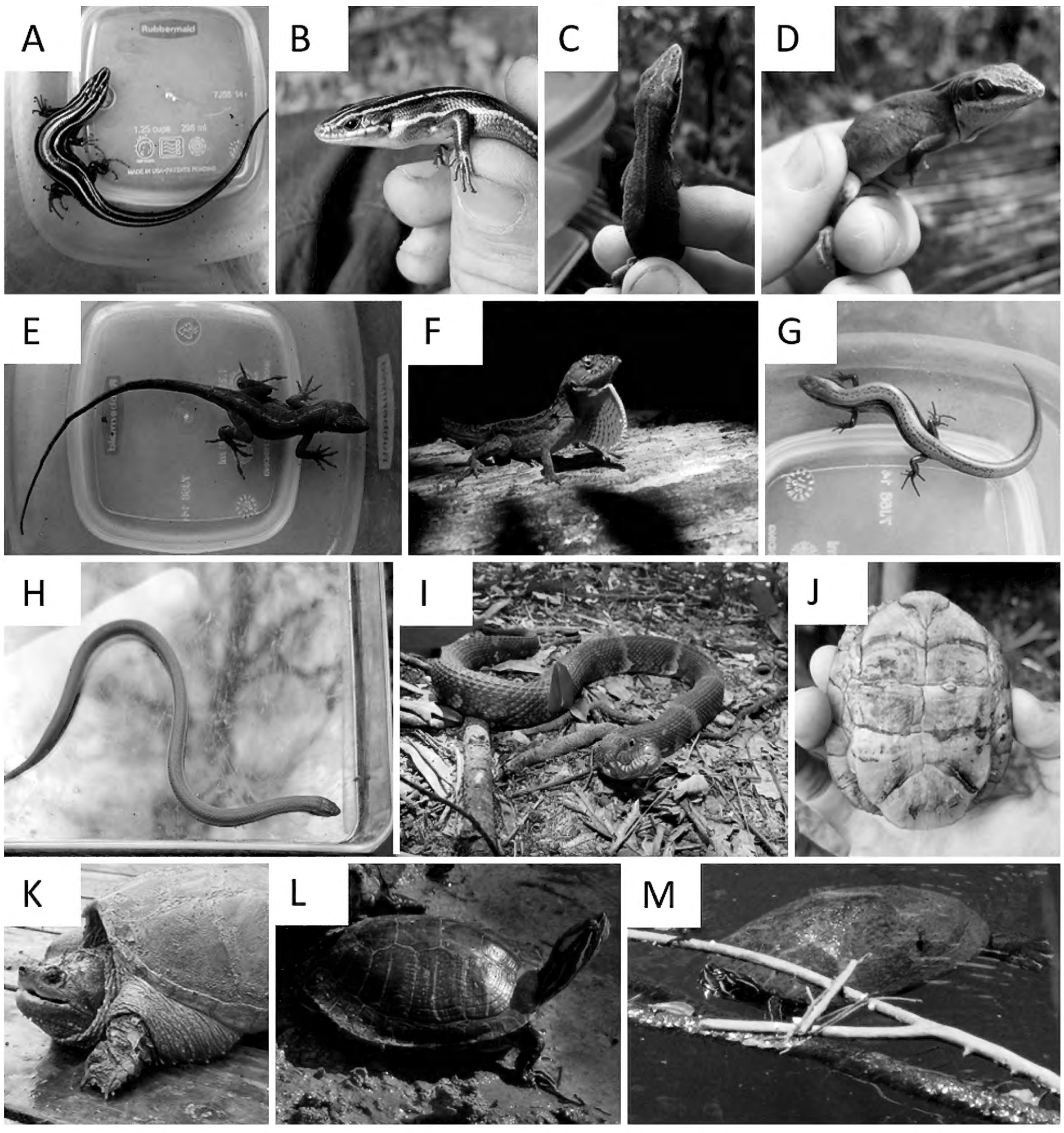

Figure 5. Reptiles found during transect surveys. **A.** *Plestiodon fasciatus* in dorsal view. **B.** *Plestidon fasciatus* view of labial scales. **C.** *Anolis carolinensis* in dorsal view. **D.** *Anolis carolinensis* in lateral view. **E.** *Anolis sagrei* in dorsal view. **F.** *Anolis sagrei* dewlap. **G.** *Scincella lateralis.* **H.** *Haldea striatula.* **I.** *Nerodia fasciata.* **J.** *Terrapene carolina* plastron. **K.** *Chelydra serpentina.* **L.** *Trachemys scripta.* **M.** *Psuedemys cocinna.*

5 families and 4 genera, and 17 reptile species [4 turtle, 8 snake, and 5 lizard] from 7 families and 13 genera) belonging to 12 families and 17 genera. When comparing survey data with iNaturalist data, we found iNaturalist data included *Heterodon platirhinos* (Latreille, 1801), *Hyla cinerea* (Schneider, 1799), *Micrurus tener* (Baird & Girard, 1853), *Nerodia erythrogaster* (Forester, 1771), *Nerodia rhombifer* (Hallowell, 1852), *Plestiodon laticeps* (Schneider, 1801), *Storeria dekayi* (Holbrook, 1839), and *Thamnophis proximus* (Say, 1823), none of which were observed during our VES. Conversely, the VES data showed the presence of *Terrapene carolina* (Linnaeus, 1758), *Rana sphenocephala* (Cope, 1886), and *Eluetherodactylus cystignathoides* (Cope, 1877), which had never been reported in iNaturalist from this location. Our VES and iNaturalist data combined, provided a more complete picture of the existing herpetofauna in Edith L. Moore Sanctuary (Table 1).

However, compared to all of Harris County, Texas, which includes Houston and surrounding urban, suburban, and rural areas, 10 species of amphibians and 32 reptile species known from the county are not known to occur in the preserve: Amphibians: *Acris blanchardi* (Harper, 1947), *Ambystoma maculatum* (Shaw, 1802), *Ambystoma texanum* (Matthes, 1855), *Gastrophryne olivacea* (Hallowell, 1856), *Hyla squirella* (Daudin, 1800),

Hyla versicolor (LeConte, 1825),*Rana areolata* (Baird & Girard, 1852), *Notophthalmus viridescens* (Rafinesque, 1820), *Pseudacris fouquettei* (Lemmon, Lemmon, Collins & Cannatella, 2008), *Siren intermedia* (Barnes, 1826); Reptiles: *Agkistrodon contortrix* (Linnaeus, 1766), *Agkistrodon piscivorus* (Lacépède, 1789), *Alligator mississippiensis* (Daudin, 1802), *Apalone spinifera* (Le Sueur, 1827), *Aspidoscelis sexlineata* (Linnaeus, 1766), *Coluber constrictor* (Linnaeus, 1758), *Coluber flagellum* (Shaw, 1802), *Crotalus atrox* (Baird & Girard, 1853), *Crotalus horridus* (Linnaeus, 1758), *Deirochelys reticularia* (Latreille, 1801), *Diadophis punctatus* (Linnaeus 1766), *Farancia abacura* (Holbrook, 1836), *Graptemys pseudogeographica* (Gray, 1831), *Hemidactylus turcicus* (Linnaeus, 1758), *Kinosternon subrubrum* (Lacépède, 1788), *Lampropeltis calligaster* (Harlan, 1827), *Lampropeltis holbrooki* (Stejneger, 1902), *Macrochelys temminckii* (Troost, 1835), *Nerodia clarkii* (Baird & Girard, 1853), *Nerodia cyclopion* (Duméril, Bibron & Duméril, 1854), *Opheodrys aestivus* (Linnaeus 1766), *Ophisaurus attenuatus* (Cope, 1880), *Pantherophis obsoletus* (Say in James, 1823), *Phelsuma laticauda* (Boettger 1880), *Plestiodon septentrionalis* (Baird, 1859), *Pseudemys texana* (Baur 1893), *Ramphotyphlops braminus* (Daudin, 1803), *Regina grahamii* (Baird & Girard, 1853), *Sternotherus carinatus* (Gray, 1856), *Sternotherus odoratus* (Latreille, 1802), *Terrapene ornata* (Agassiz, 1857). Salamanders and venomous snakes were not found on the property during surveys. As expected, the species richness of herpetofauna at Edith L. Moore represents a relatively small sample of all the species known to occur in Harris County, Texas.

Conclusions. Protection of urban nature sanctuaries is necessary for conservation efforts. Without them, urban residents lose an important avenue to connect with nature. However, having these parks simply exist in name is not enough. Although the diversity of herpetofauna at Edith L. Moore Nature Sanctuary consisted of 24 species during this study, several species common to the surrounding area were entirely absent. For the public to gain a greater appreciation of conservation efforts it is imperative that Edith L. Moore Sanctuary prioritizes maintenance of their biodiversity. Future work should include continued monitoring with improved surveying techniques that target specific species. Additionally, further research into understanding why usually common species are absent could help inform restoration and rewilding efforts at Edith L. Moore Sanctuary so that it may continue to sustain a landscape that can support a diverse herpetofauna for the public to continue to enjoy.

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Authors' Contributions

DJ was responsible for data collection, analysis, and project design. BF was responsible for coordination between DJ and the study site. LF was responsible for project oversight and design. All authors read and edited the manuscript.

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